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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/698,964	10/31/2003	Kenneth O. McElrath	3006.001800/KDG	8810

23720 7590 08/06/2007
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EXAMINER	
ONEILL, KARIE AMBER	
ART UNIT	**PAPER NUMBER**
1745	
MAIL DATE	**DELIVERY MODE**
08/06/2007	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/698,964	MCELRATH ET AL.	
	Examiner	Art Unit	
	Karie O'Neill	1745	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 May 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1 and 4-17* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1, 4-17* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on May 21, 2007, has been entered.

Claims 2 and 3 have been cancelled. Therefore, Claims 1 and 4-17 are pending in this office action.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 1, 5-6 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smalley et al. (US 6,683,783 B1) in view of Kawamura et al. (US 6,706,431 B2).

With regard to Claims 1 and 5-6, Smalley et al. disclose a method of purifying a mixture comprising single walled carbon nanotubes (SWNT) wherein the SWNT are derivatized with a functional group (column 2 lines 45-48). The single walled carbon nanotubes form a mat or "bucky paper" having a thickness of about 100 microns (column 14 lines 43-46). Smalley et al. also disclose a catalyst metal comprised of one

or more of the Group VI or VIII transition metals such as chromium, molybdenum, tungsten, iron, cobalt, nickel, rhodium, palladium, osmium, iridium, platinum and ruthenium (column 7 lines 4-15 and column 23 lines 33-46) in contact with the mat of carbon nanotubes. The SWNT exhibit a high level of conductivity, fewer defects than multi-walled carbon nanotubes and are very strong (column 5 lines 49-56). Smalley et al. does not disclose the use of the SWNT to form a fuel cell electrode.

Kawamura et al. disclose the use of carbon nanotubes in the production of fuel cell electrodes (see abstract and column 2 lines 45-50). Therefore, at the time of the invention it would have been obvious to one of ordinary skill in the art to use the single walled carbon nanotubes of Smalley et al. in the production of fuel cell electrodes, because Kawamura et al. teach increasing the efficiency of the fuel cell by using carbon nanotubes (column 2 lines 46-50).

With regard to Claim 12, Kawamura et al. disclose the single walled carbon nanotubes being used as electrode material in a proton exchange membrane (column 1 lines 66-67). Therefore, at the time of the invention it would have been obvious to one of ordinary skill in the art to use the SWNT of Smalley et al. for an electrode in a PEM fuel cell, because Kawamura et al. teach PEM fuel cells being the most promising fuel cells for widespread transportation and for operating at relatively low temperatures, fast response times and high energy density (column 2 lines 1-3).

4. Claim 4 is rejected under 35 U.S.C. 103(a) as being unpatentable over Smalley et al. (US 6,683,783 B1) in view of Kawamura et al. (US 6,706,431 B2), as applied to Claims 1, 5-6 and 12 above, and in further view of Fisher et al (US 6,203,814 B1).

Smalley et al. and Kawamura et al. disclose the SWNT for use in a fuel cell electrode in paragraph 3 above, but do not disclose wherein the functional group is a carboxylic acid.

Fisher et al. disclose a method of making functionalized nanotubes wherein the graphitic nanotubes or fullerenes are functionalized by chemical substitution (see abstract). Fisher et al. also disclose the use of a polycarboxylic acid in the process to functionalize the carbon nanotubes (column 7 lines 32-41). Therefore, at the time of the invention it would have been obvious to one of ordinary skill in the art to use a carboxylic acid to functionalize the SWNT of Smalley et al. and Kawamura et al., because Fisher et al. teach the presence of the carboxylic acid aiding in the linking of nanotubes to form the mat or lattice layout (column 7 lines 32-46).

5. Claims 7-11 and 13-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Smalley et al. in view of Kawamura et al., as applied to Claims 1, 5-6 and 12 above, and further in view of Hampden-Smith et al. (US 2003/0198849 A1).

Smalley et al. and Kawamura et al. disclose the fuel cell electrode in paragraph 3 above, but do not disclose wherein the catalyst metal is present in an amount less than 400 $\mu g/cm^2$ of the planar area of the mat of carbon nanotubes and wherein the electrode provides greater than $1mA/cm^2$ per $\mu g\ Pt/cm^2$ of the planar area of the mat of carbon nanotubes.

With regard to Claims 7-11, Hamden-Smith et al. disclose electrocatalyst powders and energy devices using the electrocatalyst powders. The reference teaches the use of homo- and hetero-fullerene and carbon nanotube based materials as an

active component in the reduction of oxygen (paragraph 109). Hampden-Smith discloses an electrode structure utilizing platinum as the catalyst and having various surface loading values such as of 0.4 mg Pt/cm2 (paragraph 417), 0.1 mg Pt/cm2 (paragraph 417), 0.05 mg Pt/cm2 (paragraph 416). Hampden-Smith does not explicitly teach an electrode with a surface loading of 0.025 mg Pt/cm2 or 0.010 mg Pt/cm2, however the it would have been obvious to one having ordinary skill in the art a the time the invention was made to use the absolute minimum amount of platinum catalyst in the electrode of Smalley et al. in view of Kawamura et al. necessary for proper cell performance. This decreases the total amount catalyst required and therefore reduces cell weight and increases the power density of the fuel cell.

The comparisons discussed in Hampden-Smith evaluate cell performance employing various surface loading values concluded that the cell performance was virtually identical for a cathode loading of 0.1 mg Pt/cm2 and a catalyst loading of 0.4 mg Pt/cm2 (paragraph 415-417). The courts have held that the determination of optimum values of cause effective variable such as catalyst surface loading values require only ordinary skill in the art. *In re Boesch*; 205 USPQ 215 (CCPA 1980).

With regard to Claims 13-16, Smalley et al. and Kawamura et al. disclose the electrode being a component in a PEM fuel cell, wherein the catalyst metal comprises platinum, and wherein the carbon nanotubes are single walled carbon nanotubes.

Hamden-Smith et al. disclose a membrane electrode assembly (MEA) having a supported active species (platinum electrocatalyst) loading of 0.1 mg/cm2 and a current density of 150 mA/cm2 (paragraph 38). Therefore, the electrode provides greater than 150 mA/cm2 per 100 pg/cm2 of the area of the carbon nanotubes. As well, Hampden-

Smith discloses a membrane electrode assembly having a supported active species (platinum electrocatalyst) loading of 0.1 mg/cm2 and a current density of 150 mA/cm2 (paragraph 38). Therefore, the electrode provides greater than 150 mA/cm2 per 100pg/cm2 of the area of the carbon nanotubes. Also, the reference teaches that the performance of the MEA is primarily judged by reference to the relationship between the cell potential and the current density (paragraph 279, Figure 10). The reference teaches that it is advantageous to achieve a higher current density at a higher voltage and to maximize cell performance at low platinum loading (paragraph 286).

Although the current density is not explicitly stated as greater than 10, 50, or 100 mA/cm2 per g/cm2, it would have been obvious to one having ordinary skill in the art at the time of the invention to optimize the performance of the MEA (see Claims 66-70 of Hamden-Smith). It has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch,* 205 USPQ 215 (CCPA 1980).

With regard to Claim 17, Hamden-Smith et al. disclose the use of a direct methanol fuel cell (paragraph 314). Therefore, at the time of the invention it would have been obvious to one of ordinary skill in the art to use the electrode of Smalley et al. and Kawamura et al. in a direct methanol fuel cell, because Hamden-Smith et al. teach different types of fuel cells are categorized by the electrolyte used in the fuel cell. One of the critical requirements for these energy devices is the efficient catalytic conversion of the reactants to electrical energy. A significant obstacle to the wide-scale commercialization of such devices is the need for highly efficient electrocatalyst materials for this conversion process.

Response to Arguments

6. *Applicant's principal arguments are:*

(a) Fisher does not suggest the nanotubes are single walled carbon nanotubes, but rather fibrils, which are quite different than single walled carbon nanotubes.

In response to Applicant's arguments, please consider the following comments:

(a) Fisher teaches fibrils as well as nanotubes or "buckytubes" (see abstract). Because Smalley et al. teaches SWNT, Kawamura et al. teaches the use of carbon nanotubes in fuel cell electrodes and Fisher et al. teach a method of making functionalized nanotubes, it would have been obvious to one of ordinary skill in the art at the time of the invention to derivatize the SWNT of Smalley et al. with carboxylic acid taught by Fisher et al. in order to permit interaction or linkage of the nanotubes with substrates to form compositions with unique properties (column 3 lines 46-56 and column 17 lines 6-26).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Karie O'Neill whose telephone number is (571) 272-8614. The examiner can normally be reached on Monday through Friday from 8am to 5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick Ryan can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Karie O'Neill
Examiner
Art Unit 1745

KAO

DAH-WEI YUAN
PRIMARY EXAMINER